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CONTENTS

Space and Reality: II. Real Space: JOHN E. BOODIN 589

The Pragmatist's Meaning of Truth: JOHN E. RUSSELL 599

The Telephone and Attention Waves: GEORGE L. JACKSON 602

Discussion:

Metaphysics, Science or Art: KATE GORDON 604

Reviews and Abstracts of Literature:

Duhem's La théorie physique; son objet et sa structure: EDWARD G. SPAULDING 606

Browne on The Psychology of the Simple Arithmetical Processes: A Study of Certain Habits of Attention and Association: E. L. NORTON 610

Journals and New Books 613

Notes and News 614

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SPACE AND REALITY[1]

II. Real Space

We have so far examined into the presuppositions of space construction and found that these must be expressed in biological terms. We next took up the ontogenetic side of our space perception and found that the content, in so far as it exists, is probably concomitant to the going on of the growth process, determined by the phylogenetic tendencies and intra- and extra-organic stimuli. What actual content there is, moreover, must be determined by statistical inquiry, and not *a priori*. We then examined into geometrical construction, and found this to be a matter of logic and to be conducted as any free logical inquiry. The ideals, however, of mathematics, as other ideals, seem to have a phylogenetic basis. Lastly we examined into the conception of space, as perspective, by metaphysical idealism. When regarded as phenomenal we had no reason to quarrel with this view. When, however, translated into terms of absolute idealism, as by Fichte, space loses its significance.

We must now turn to the other aspect of our concept and try to discover what the real space zero means or what difference it makes in our accounting for the facts of experience.

The series aspect of space, we have agreed, is subjective construction. Points exist only as we posit them as the ideal pegs on which we hang our qualitative world. To make up a real world of such ideal points is absolute nonsense. But what remains after we abstract from this series character? Nothing at all, is the answer. But that nothing we shall try to show is not a merely ideal nothing, but a real nothing which conditions not only subjective construction, but real action as well.

First of all such a space zero is perfectly conceivable. The modern study of number has shown that the conception of nothing does

[1] This paper concludes the author's discussion of this subject. His first paper, under the subtitle of 'Ideal or Serial Space,' appeared in this Journal, Vol. III., No. 20.

not equal no conception. It is not 'unthinkable' and 'unspeakable,' as Parmenides and Melissos dogmatically maintained in regard to just the space zero. The zero of the number series is of basic importance in the whole conception of the number series; and as the number series is not intelligible without it, the number zero possesses all the reality of the series which it limits. But we can conceive empty space, as we conceive the number zero, as a limit by abstracting from the contents of space or the things in space. Hence space must be as real as the things in space. It is a matter of surprise that though the importance of the zero concept for number has received so much attention in recent times, the importance of the space zero, which both chronologically and ontologically is more fundamental, should have been ignored. But the reason for this can be found in the fact that since Kant thought has been more interested in its own machinery than in its objective conditions.

Once having shown the conceivability of empty space we must prove its existence, as we prove the reality of any other concept, by showing its convenience for describing the facts of experience. The criterion of the reality of our concepts is everywhere the same: Does the concept work? Does it make experience simple, consistent and intelligible? Must we act as if it were so?

We must conceive of empty space as the precondition of filled space, as the limit of exhaustion of filled space, which, moreover, we can approximately get. If by exhaustion we could get the space zero without content or resistance, it must have been real all the while. It is not necessary to the reality of spatial non-being that it should actually exist separately or empty. If we can approximate it as a limit, it must be just as real as though it existed separately. We can not get the quality of blue separate from all other facts, yet we do not therefore deny its existence. It is convenient, at any rate, to conceive of a space-nothing, whether empty or filled. Only with reference to it can relative emptiness or relative resistance have meaning. To illustrate, let us take this instance suggested by my friend, Dr. Bruce Hill: Hydrogen gas is the only gas that passes through platinum. Suppose, then, that you have a vessel of platinum filled with pure hydrogen gas. Let this escape, and what is left?

The conception of a space zero has proved convenient as a limit in conceiving Newton's first law of motion. While this law is an abstraction, it must be remembered that such abstraction is empirically possible to a certain extent. The abstraction, therefore, is not merely ideal. On the contrary it is real non-being which we find it convenient to conceive in treating of resistance and motion. I can hardly see how a merely ideal limit could make any difference to actual movement. Thus points, lines and surfaces, while legitimate

mathematical abstractions, neither obstruct nor facilitate movement. Even if we have not been able to get absolutely empty space we can, as already shown, approximate to it and predict definitely what would happen if we could get it. The only problem is: Are we compelled to assume such a zero in order to account for the facts of experience? Having assumed such a real zero, we find it easier at any rate to account for the forms of motion as they actually take place owing to the resistance and diversity of the physical world. The convenience of the conception must indicate that it has a foundation in the real, otherwise it could not be empirically approximated as well as hypothetically useful. It is the real limit which makes our conception relevant.

Even geometry in assuming free mobility as one of its few remaining axioms shows that it means by space something more than series, for free mobility is the very precondition of space construction. If, after abstracting from things, space itself offered resistance, geometry would not be possible. Even in geometry, therefore, non-being space is presupposed as objective to serial construction.

This conception of space explains distance, which can not be explained as a property of things and yet conditions the actions of things. By distance I do not presuppose our geometrical concepts such as the straight line. A straight stick is more convenient than a crooked stick for social measurements, but in either case we presuppose the separateness or side-by-sideness of perceptual processes. A yard stick, while a convenient unit, does not create the distance it measures. This is different, moreover, from the ideal distance or stretch in our conception of series, for example. Distance transferred to mental processes and their externality is only a figure of speech. Space distance is the only real distance we can conceive. All other distance or stretch depends upon this. To make number distance or tone distance possible, we must spread out our qualities in space. Except for space distance all qualities or facts would have to coalesce or interpenetrate. Empty space, then, must be real, if pure distance must be conceived as real.

I can not see how the conception of distance, with all it implies for reaction on every plane of existence, can be reduced to a property either of physical things or of selves, yet without this fact both acceleration and the limitations of intersubjective communication become unintelligible. Wills, appreciative selves, are not extended, but are limited by conditions of separateness, not of their own making, but which must be met and can not simply be brushed aside as illusions. Here lies the difference between the derivative conception of distance or stretch in series such as the number and tonal series. Here the distance or stretch is determined by the will, is comprised within its

purpose. A long stretch or a short stretch will serve equally well to spread out its contents; and as the termini are simply of the will's own positing, they put no condition upon the will as regards passing from one to the other. They are only ideally external within a unity of consciousness which claims them equally and *simul.* Not so with space distance. Here the distance limits the will and the realization of its purposes. The distance which separates Kansas and Harvard and limits my intercourse with its group of divine philosophers is not the creature of my ideal positing simply; my ideal bridging of it does not remove the limitation to my will as in the case of two points in a series. If it is posited by me, it is because I am compelled to do so, and no ideal enlightenment from my Kantian friends serves to sweep the limitation away. In short, what makes other egos and things objective to me, *viz.,* their independence of my subjective purposes, makes also space as distance objectively real to me. As I must 'acknowledge' other egos, so in order to realize my practical purposes I must 'acknowledge' space. Space is the condition of the externality of egos and things, whether they can be 'acknowledged' as egos or not. It is not a subjective, but an intersubjective condition, limiting the communication and cooperation of egos. Within the ego space exists at most only figuratively, as when we speak of the space of our ideas.

I know we often speak, in this age of electricity, of annihilating distance. It is true that social sympathy and unity are possible in this age to an extent they never have been before. Humanity by means of the telegraph can live a common life to a marvelous degree. And yet it is loose language even so to speak of the annihilation of distance, for distance does make a decidedly measurable difference to our communication. However much the conditions of social life have altered since the days of the proximity of savage tribal life, still it makes a difference to the kind of relations we can have with each other that we are separated by distance.

Our space conception must be such in the end as to satisfy our space intuition. While we must not invoke intuition as explanation, yet where our intuitions, as in our general reactions upon our environment, are due to survival selection, they have, as Spencer says, well-nigh the force of demonstration and must not be lightly brushed aside. While the space intuition can not be expected to separate sharply between the physical and spatial character of our world, and while in it we find such physical categories as three-dimensionality and continuity mixed with such spatial categories as non-resistance and distance, yet the unspoiled space intuition always has insisted upon an ontological non-being as over against physical and subjective beings. Hence the natural part the void plays in early

cosmogonic and physical theories. However much cruder the tools of Leucippus and Democritus than those of Kant, yet their conception of an ontological nothing gives a more fundamental character of the space concept than the aspect of serial construction emphasized by the Kantians.

This conception of space greatly simplifies the problem of the attributes of space and hurls the objections, with which the concept of space in the past has been burdened, back into the realm of the subjective, the realm of tools, where they belong. Thus empty space can not be said to be extended. Things are extended, not space. Extension like color is the relation of energy to our psychophysical organism. To speak of a colored energy or, to use a known type of energy, a colored will, would be as sensible as speaking of extended energy or extended will. Extension has probably its physiological basis in the number of physiological elements, peripheral and central, which are stimulated, as color has its basis in a certain retinal structure. It is a relation, therefore, an equivalent for certain changes, not an entity, and in so far as relations for the time being are real, so extension and color must be regarded as real. But they are physical qualities, not space qualities. When we once get rid of the notion of energy as extended and come to regard extension as a subjective equivalent for a certain form of irritation, the superstition against action at a distance and the absurdly contradictory ether medium will probably vanish. Energy is where it does work. There is nothing against energy radiating or connecting up in empty space but the prejudice that extension has a different sort of objectivity than color or taste. The conception of continuity likewise will be taken out of court so far as space is concerned. The spreading or radiating of energy creates its own continuity. A continuous nothing is as meaningless as a discrete nothing. The continuities and the discontinuities, the fluidities and the interferences, must be expressed in physical terms; and physics has wisely substituted mathematical equations for mythological media depending upon certain gross forms of psychological imagery hypostatized. The equations have nothing to do with whether action is due to the radiation from energizing center to center over pure distance and the resistances due to interferences of the radiations, or whether there is an extended medium, such as ether. Rays or spreadings of energy, whether with or without a medium, are at least the only physical continuity I can conceive. Centers corresponding to wills, however much simpler in character, are the only energetic discontinuities I can conceive.

The hypostatizing of a medium such as the ether medium is due to custom. In our gross sense-perception one end of a rope appears

to be of a piece with the other end. Not so if we substitute molecular action for our gross sense-continuum. Still, even then, owing to our ingrained custom, it seems uncanny, to use Mr. Hill's expression, for one thing to move another without something between.

While to speak of the transmission of energy in an *extended* medium is to confuse two different orders of being, it is still true that extension is intimately bound up with the space character, as duration is with the time character. While extended energy or extended will is what Descartes would call a confused idea, and while extensity or voluminousness is a subjective fact, yet the multiplicity of stimuli and their externality which are the necessary conditions of such feeling of extensity must, at any rate, be characters of the real world.

The question has been raised as to the relation of diversity or multiplicity to space. In answer to this I wish to say that it is possible to have distinction of qualities or properties without spatial spread-outness. The same thing or individual, in other words, may possess many qualities, all of which interpenetrate or occupy the same space. If they did not, the unity of the thing would be impossible. Thus the watch is yellow, hard, cold, round, ticks, etc. It sustains a diversity of chemical, physical, commercial, esthetic and other relations to other individuals. Psychologically this locating of qualities and relations in each other's space is no doubt the result of the law of economy. But this law itself has been forced upon us as a result of the practical necessities of adjustment. These qualities, moreover, are no less distinct because they occupy the same space. Here in the unity of the thing we come the nearest to having an ontological point, for a thing, whether conceived psychologically as a complex of qualities or metaphysically as an energetic entity capable of certain reactions, while it is in space, can not be said to occupy space. The problem of spatial externality arises only when we must ' acknowledge ' different coexisting and interacting individuals, whether egos or things. This, moreover, has nothing to do with multiple selves, for in the first place these are generally successive, and we are dealing here with simultaneous discreteness. In the second place, in the case of multiple selves, the psychophysical basis of consciousness has become disintegrated or dissociated in some way, so that while we have one skin, we have really more than one space thing. What again we shall recognize as an individual depends greatly upon our selective purpose and may vary all the way from the electron to the universe.

The stock objections brought against space as quantitative and serial would one and all be irrelevant to this conception of space. Space as real zero is neither made up of parts nor a whole; it is

neither one nor many; neither continuous nor discrete; neither infinite nor finite; neither quantitative nor qualitative. These are one and all ideal constructions to manipulate processes in space. If they lead to contradictions, that only shows the crudity of our conceptual tools. It does not discredit space any more than processes in space.

Since space is not quantitative, it does not consist of spaces added to spaces, nor is it the unity of spaces. This is simply the gross imagination of minds, not accustomed to logical abstraction, who confuse sense things, barrelfuls and bucketfuls, with space. Thus the conception of a real zero-space saves us from the antinomies to which the conception of a real serial space has given rise, and shows the subjective character of the antinomies, not of space.

Even dimensionality can not be regarded as a space category. Whether the world of physical processes must be conceived of as having one, two, three or n dimensions, as having positive, negative or zero curvature, can not be settled *a priori,* but must be ascertained as we ascertain any other attribute of the constitution of our physical or perceptual world. That we arrange our perceptions according to three axes or systems of coordinates is due proximately to our being equipped with three spirit-levels, the semicircular canals, the convenience of which, however, seems to point to a certain structure of the physical world.

It has been suggested that while space can not be said to have any particular number of dimensions it still must possess dimensionality. But all that could be meant, so far as I can see, by this dimensionality in general is simply the indifference on the part of space to any particular determination, and hence the possibility of being determined by means of such a system of coordinates as the character of the physical world may require. I can not see, however, how you can have coordinates that are no coordinates in particular.

It might be objected in that case that neither can externality or distance exist without termini or facts and, therefore, that distance involves dimensionality. To this I would reply that measured or particular distance can only exist in a world of individuals, and with such a world we have dimensionality as well. That, however, does not prevent us from logically distinguishing between them and from regarding one as a physical attribute and the other as a space attribute, for while we can and must abstract the distance character and treat it as an independent variable, both in our physical equations and in our inter-subjective intercourse, we can not thus abstract the axes or coordinates from the stuff structure of our world. Dimension in general, in other words, is merely a matter of sub-

jective abstraction, while space as the condition of distance is a *forced* concept.

Space can properly be said to have only two attributes. It is the condition for free mobility and for distance. Free mobility or reversibility, though the absence of character in the sense of any positive determination, becomes an important attribute as a limit in conceiving motion. It means that space as such does nothing to things moved in space. As distance, space is not the mere ideal form of externality, but the real condition or objective possibility of the externality of things or egos. It is with reference to the qualitative and quantitative diversity of the world pure passivity, not the passivity of Plato, Aristotle or Hegel, which after all is such as to distort the pure forms or make them fall short of realization, but passivity as the absence of resistance, thus throwing the responsibility for what happens on the character of things. The only condition it imposes on things is that of distance and that condition it imposes on the world of appreciation as well as on quantitative motion.

The objections brought against empty space by Aristotle are different. They aim at the real space concept. They may be classified under two heads: those due to prejudice, or his own space concept; and *argumenta ad hominem* as against the space conception of the atomists. Aristotle's own conception of space is that of figured, continuous extension, 'the limit of the surrounding body in respect to that which it surrounds.' Hence space for Aristotle is finite, limited by the limits of the world, and conversely it becomes absurd to speak of space outside the world, or empty space. As we have rejected Aristotle's conception of space already as regards its extension and its figured character, his objections from this point of view need not detain us. They simply amount to dogmatism, not criticism. No doubt Aristotle is right that the universe of things, whether bodies or selves, is a finite affair. Science believes in a limited number of chemical substances; a limited number of stars and astronomical positions; a limited number of human beings for census purposes, etc. To speak of infinite variety or infinite attributes is simply a rhetorical figure on the part of poetical philosophers, showing at most the unchecked character of their imagination. A real infinite world, whether as regards extent or diversity, would make science as impossible as would multiple independent worlds. Facts must have a certain relation to each other, must make a difference to each other, and these relations and facts must be finite to make knowledge possible. But a finite universe has nothing to do with a finite or infinite space. Facts determine each other. The arrangement of things in space, the different

meanings, qualities and values things have are due to the relations of things to each other or the way they are connected up. Space does not determine them except as regards distance, and that would be irrelevant where there are no facts.

As regards Aristotle's criticisms of the atomists, they are on the whole well taken as *argumenta ad hominem.* Empty space does not account for motion or rest; it accounts for no tendency downward or upward; much less can it account for the different rates of motion as faster or slower in so far as you abstract from the relations of bodies. Democritean atomism, which had assumed that heavier atoms, in a void, would fall more rapidly than lighter and thus would collide and form a whirl, was not able to stand against Aristotle's criticisms; and the crude view of 'natural places' displaced the atomic whirl. Motion and differences of motion must no doubt be accounted for by the constitution of the physical world, except in so far as the conception of distance is involved in the conception of motion or communication.

This conception saves us from the absurdity of regarding space both as serial and as real, as our construction and as conditioning the world of processes. The contradictions of this position have been sufficiently battered to pieces from Zeno down. The serial must necessarily be our subjective construction, our tool for manipulating processes or facts. This position, therefore, allows for the truth of idealism. It admits the conclusions of idealism so far as it goes, but at the same time it does justice to the surd which realism has always felt to remain and the omitting of which has made idealism so ghostly, bottomless and incredible. Common sense is right, if it can only be made to understand itself.

Nor can we regard space subjective and motion objective, the half-way house of Lotze and others. If we regard motion and change as objective, we have to regard space as objective. This is true of qualitative change as well as quantitative, as the former too would be impossible without some kind of pluralism and externality. Melissos saw deeper than he knew when he maintained that if there is rearrangement there must be empty space, even though he supposed the conclusion to be absurd (taboo it really had become, and has been mostly since, to regard non-being as real) and so returned to the solid-block universe of Parmenides, which he conceived as unlimited to exclude empty space from the outside.

In explaining motion we have found empty space useful in two ways. First, it makes it possible to abstract from bodies and resistance, and so to state Newton's first law of motion. Secondly, it gives us the possibility of objective distance, which can not be reduced to the properties of things. Reactions of things, while they

are determined by the properties of things, also vary with the distance, which, therefore, can not be regarded as merely subjective. It is hard to see how mere subjective position could influence the intensity of motion. Motion in an ideal space should be consigned to the confused limbo of square circles, mermaids and centaurs.

Most important of all is the fact that this conception of space satisfies the criterion made so much of by the idealists themselves, and more than once implied in the preceding, *viz.*, that those conditions which limit and must be taken account of in the realization of purpose must themselves be real. Otherwise they would not be conditions. Space and time must certainly be taken account of in realizing our human purposes; therefore, they must be as real as those purposes themselves. If they were merely illusion, or 'mere appearance,'[2] then it ought to be possible to ignore them, at least after finding out the truth about them. Take space distance, for example. Our measurement of this with reference to geometrical ideals, such as the straight line, our use of a particular kind of measuring rod, such as the yardstick, must be regarded indeed as a matter of ideal selection and control. But if I live in Kansas and an important philosophical session is held in New York, or I want to see my friends across the sea, the mere declaring space an illusion does not annihilate the limitation. Intermediary processes must somehow be reckoned with; and those processes presuppose space as the condition of their externality. Thus space as distance conditions the equations of the astronomer and the joy and communion of willing selves. And so with time. No mere conversion to absolute idealism will make new wine old, will convert youth into old age or make the faded flower bloom again. I do not see how in the only world of purposes of which we know anything, it is possible to ignore the space and time limitations of those purposes. We grant that the space and time characters taken apart are meager enough when contrasted with the concrete life of feeling and willing. We are indeed in our inmost beings willing and appreciative selves. But space and time remain, nevertheless, irreducible limits to which we must adjust ourselves, if we would be sane, not deny; and in so adjusting ourselves realize our purposes.[3]

I do not insist upon a different reality for space than for egos

[2] I can not help thinking, notwithstanding the objections of the Kantians, that the psychological term illusion is a fair equivalent for Kant's 'mere appearance.' For illusion is not baseless, but it owes its character to the apperceiving subject rather than the stimulus. It is a mode of apperception, but not true of the real.

[3] For the author's treatment of time, see his monograph, 'Time and Reality,' the *Psychological Review Monograph Supplements*, No. 26, also his article, 'The Concept of Time,' this JOURNAL, Vol. II., No. 14.

or things, *i. e.*, for energy, whatever form it may take. All I insist upon is that we must 'acknowledge' both. The question whether space could exist before things could only have meaning for those who, with the medievals, regard the world of things as created at a finite time out of nothing, as embodying eternal archetypes or what not. It is the province of philosophy like science, however, to investigate the constitution of the world, not its creation. The temporal priority of space to things can, therefore, have no significance for us. We can, however, abstract distance from things and must do so, both for purposes of physical science and for practical life.

If one should hold with the absolute idealist that there is only one individual, one unitary experience in which all facts are modes or qualities, one completed purpose, one simple feeling, then reality would cease to be definable in space terms. In the one blissful moment of the absolute, distance could have no significance. All I can say is that, in the only reality we know anything about, we are forced to recognize different individuals and their externality.

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THE PRAGMATIST'S MEANING OF TRUTH

I THINK it can be safely assumed that the readers of this JOURNAL by this time know sufficiently well what the pragmatist means by truth, by a true idea. In this brief article I shall attempt to show that this meaning is not the correct one, that it is not the correct meaning of truth, even if the pragmatist's contention be admitted that truth in every case of it is useful, that every true idea does lead to beneficial consequences, to desirable experience of some sort. The proposition I shall maintain is, that in any situation in which an idea does lead to profitable or desirable experience, it is not these consequences which make this idea true, but this idea is able to lead to these consequences because it is true, and true because of something which the pragmatist overlooks. To be more specific, admitting that the true idea does always possess a practical value, does have the instrumental function which the pragmatist assigns to it, I shall attempt to show that the pragmatist has not rightly answered the question, *how* is a given idea able to lead to these prosperous and satisfying issues, how *can* it have this instrumental function?

My position can best be made clear by the study of a concrete instance. Let us suppose a sojourner in the Adirondacks is lost in one of those forests. He is without shelter and without food; and

unless he finds both he must perish. The problem in this situation is a practical one; and if this man has a true idea, it will certainly be a useful one. We will suppose this problem was solved, the true idea found; and, accordingly, my question is, in what consisted the right solution of this traveler's problem? What made this man's idea a true one? Let us analyze the situation. There was (1) the environmental conditions, *viz.*, the *forest* having a determinate configuration and extent, the house where food and shelter were, and a determinate direction or way leading to that house. (2) The man's idea, dealing with this situation, *viz.*, his idea of this environment, his idea of the situation of food and shelter, and the way he must take to reach them. (3) The man's action under the lead of an idea. (4) The resulting enjoyment of food and shelter, the prosperous issue of the idea. Now, the pragmatist must say, that this traveler's true idea was his plan of action and its issues; and that the trueness of this idea consisted in just these consequences. Had the consequences of following his idea been the failure to find food and shelter, that idea would have been a false one, and false just for that reason.

Now, what I wish to show is, that this pragmatic interpretation of the situation overlooks certain elements, the due recognition of which is indispensable to the correct understanding of the situation. The pragmatist fails to take account of the difference between the environmental conditions and the successful action which these conditions made possible; the exact position, form and extent of this forest, of the house where food and shelter were, the right way leading to it—*these* were the objective conditions in the situation, which determined the solution of the man's problem. They constituted the environment to which his action must be adjusted if it was to have a sucessful result; and our traveler's action was prosperous in its issues just because it was the sort of action which this environment made possible.

The pragmatist overlooks an essential element in the traveler's idea dealing with these environmental conditions; and the consequence of this oversight is, he fails to recognize that character of the idea in which its trueness consisted. Our traveler in his thought dealt first with the environmental part of the situation, and, secondly, and as a consequence, he dealt with the practical problem which this environment and his needs presented to him. The man's idea, or plan of action depended upon, was determined by his idea of the existing environment as I have analyzed it. Now, it is *this* idea which the pragmatist overlooks, and unfortunately for his interpretation, this overlooked element is of fundamental importance; it held the key to the situation; the man's solution of his problem depended upon

his idea of his environment. It was because our traveler had the *right* idea of these environmental conditions that he was able to act successfully in the given situation. Now, that which made this man's idea of his environment true, was its agreement with the actual environment. His idea was true for no other reason than that he thought or conceived this environment as it in fact was when so thought.

Our traveler's idea was not true, then, because it had beneficial results; it led to these beneficial consequences because it was true and because it was true for some other reason, *viz.*, because it agreed with the environmental conditions.

Assuming that this concrete instance is fairly representative of all cases in which there are such things as true ideas, the conclusion seems to be that the pragmatic meaning of truth does not bear the test of critical examination. Nor will the validity of this conclusion be impaired if we substitute for the realistic interpretation of the situation in our case of the Adirondack traveler an idealistic one. Let our traveler be a radical empiricist, and his real world be the world of pure experience only; in that case the environment was something real—something other than our traveler's momentary and passing thoughts; and it was this something real which determined the sort of action or experience which led to these desirable consequences, and the trueness of the man's idea was, therefore, its agreement with reality, which in this instance was the condition or order of experience. I will go even further, and suppose our traveler was a solipsist, to whom the world was his *own* experience and *his* experience only. Even in such a case if there could have been such a thing as a true idea, the truth of that idea must have consisted in something besides the *de facto* sequence of one experience upon another. In the pragmatist's meaning of truth, a relation between experiences of a more intimate sort than mere sequence is essential to a true idea. And when this relation is examined it will turn out that our solipsistic traveler had a true idea because that idea agrees with reality, which for him was the habitual or customary order of his experience. Our solipsist must have assumed a determinate character of his experience, and this character of his experience it was which made possible the right solution of his problem. So long, therefore, as anything is acknowledged to be real beyond the passing moment, the here and now, a true idea in any situation will consist in its agreement with reality, and its truthfulness will be something distinct from its *de facto* success in leading to beneficial action, or to practically useful results and satisfying experience.

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THE TELEPHONE AND ATTENTION WAVES

APROPOS of work now being done in this laboratory[1] in the investigation of the relation between the fluctuation of auditory attention and the Traube-Hering wave, it seemed wise to settle, if possible, the fundamental question: Is the fluctuation of attention, if there is any, of central origin, or is it due to lack of uniformity of the stimulus?

The apparatus used in some earlier experiments in this laboratory as well as by several other investigators was the tone from a telephone receiver. It seemed desirable, therefore, in order to meet Hammer's objections, to have some objective check upon the apparatus that would indicate not merely the strength of current, but the movements of the diaphragm of the telephone itself. To this end we had Max Kohl mount upon the diaphragm of a telephone, by a lever, a mirror that should magnify the oscillations of the diaphragm about three times. A ray of light was thrown upon the mirror through a narrow slit and reflected into a telescope with micrometer eye-piece, and the amplitude of oscillation of the mirror could thus be read directly. In our experiments the current was interrupted by a König 50 v. d. fork. In the circuit was a variable resistance and a miliammeter. It was possible, then, to read the current strength on miliammeter and telephone diaphragm with constant current, with a single throw, and with the regular interruptions produced by the tuning-fork.

Observation of the beam of light while the fork was running showed that ordinarily there was a perfectly constant current, and that interruptions, when they came, were in the nature of single long oscillations. There was no regular change in intensity that could in any way explain the fluctuations in sound that have been called attention waves. That there is a fluctuation of attention to the sound is the opinion of all six people who have acted as subjects for this investigation. All agree that for a time the sound is heard, then it is seemingly lost in a confused mass of sensations; and although one feels that the sound is still there, one is yet quite uncertain about it. Later, out of this uncertainty and confused mass the sound emerges and once more holds the field. The fluctuations are often hard to obtain. The zone of fluctuation is much narrower than the range for vision. In consequence the observers took from fifteen minutes to an hour to adjust the resistance to a point that would give certain and constant fluctuations. But no one failed to discover the fluctuations even in a single sitting, after a few days' preliminary practise.

[1] The psychological laboratory of the University of Michigan.

As the apparatus in question was adapted to a determination of the relation between current intensity and amplitude of vibration of the telephone receiver, and no one, so far as we know, has ever worked that problem out, in spite of the widely extended use of the telephone as a source of sound for psychological experiments, it was decided to make a few observations upon that point.

The method was as follows: All series of reading were begun with the ammeter standing at 20, and for each subsequent reading the current was reduced 1 ma. Standing at 20 a break and make in the current gave a reading of the deflection of the mirror in millimeters on the scale. The fork was started and the ammeter and millimeter reading taken under these conditions. The fork was then stopped with the hand, the current reduced 1 ma., and the reading, as above, taken, and so on. The different series were recorded independently of one another in order that the values of one series might not influence the judgment of values in another. The following table gives the results found for three typical series, though a graphic representation which shows by actual demonstration that these values lie in almost a straight line would be preferable..

Ammeter Reading. Fork not Running.	Millimeter Reading. Fork not Running.			Ammeter Reading. Fork Running.			Millimeter Reading. Fork Running.		
	I.	II.	III.	I.	II.	III.	I.	II.	III.
20	10	10	10	11	13.5	11	15	18	15
19	9.5	9.5	9.25	10 +	12.75	10 +	14 +	17.25	14 +
18	9	9	8.25	9.75—	12.25	9.75 +	13.25	17	13.75
17	8.5	8.25	7.5	9 +	10.5	9.25	12.25	15.75	12.75
16	7.75	7.5	7	8.5	10.25	9 —	11.25	15	12
15	7.25	7	6.25	8	9.25	8.5 —	10.25	14	11.5
14	6.75	6.5	5.75	7.75 —	9 +	8	9.75	13.75	10.5
13	6	5.5	5.25	7.5 —	9 —	7.5	9 —	13.5	10
12	5.75	5 +	5 —	7	8	7	8.25	11.5—	9
11	5 +	4.75	4.25	6.5	7.75	6.25	7.25	11	8
10	4.75	4.25	3.75	6	7	5.5 +	7	10	6.75
9	4.25	3.75	3 +	5	6.5	5 +	6	8	6
8	3.25	3 —	2.5	4.25	5.25	4.75	4.25	6.25	4.75
7	2.5	2.25	2	3.75	4.75	4	3.5	5	3 +
6	2	2	1.75	3.5	4	3.5	3	4	2.25
5	1.5	1.25	1.25	3 +	3.5	3	2.5	3.5	1.5
4	1	1	1	2.75	3	2.5	2	2.25	1
3	.75	.25	.75	2	1.75	2.25	1	.75	.5

No attempt at averaging the results has been made. As will be noticed, each of the three series is different slightly, although consistent in itself. This variation is apparently unavoidable in any work that depends upon contact make and break for its oscillations. Lord Rayleigh, it will be remembered, was constantly troubled by it in his work on self-inductance. In our results the variation is un-

doubtedly due in large part to slight changes in the position of the platinum wire that furnished the oscillating contact on the fork. We have contented ourselves, then, with giving three typical series of results that indicate at once the constancy and variability of the results. It will be noticed that there seems to be a slight relative gain of energy for the larger currents in the telephone, which makes the series increase more rapidly than the ammeter readings.

We have not attempted to fit a curve or an equation to the results, but leave them in the raw state. It will be seen that it is only very roughly that the intensity of the sound may be regarded as a function of current. Any even fairly delicate work would require correction. We have not considered here the loss of energy in the air between telephone plate and ear, which might conceivably still further modify the results.

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DISCUSSION

METAPHYSICS, SCIENCE OR ART

IN a recent number of this JOURNAL[1] Dr. Ewer contributes, under the above title, comments upon the art-character of metaphysics, in which he devotes some notice to an article of mine on 'Metaphysics as a Branch of Art.' I appreciate the courtesy of the criticism, but regret that I can not agree with his corrections.

1. Dr. Ewer holds that "The purpose of metaphysics is the purpose of science, not the purpose of art. The metaphysician aims at the discovery of truth; the artist at the production of beauty. The one constructs an idea which, he hopes and believes, correctly represents reality; the other makes a reality which expresses an idea. . . . His purpose [the metaphysician's] is to make a mental copy of reality in its important features and principles, and the thing has metaphysical worth only as it is a correct copy."[2] And the further distinction is made that metaphysics aims to tell the truth, whether pleasant or not, whereas art frankly seeks to please. Now, I believe that Dr. Ewer is quite right in adopting, as he does here, the pragmatic criterion of 'purpose.' The purpose or end of metaphysics and of art should be the test of what they are; only I do not agree to the particular purposes which are assigned. To say

[1] Vol. III., No. 20.

[2] Pp. 546–7.

that the aim of metaphysical thought is to copy reality is to make that thought mechanical and purely representational. I leave others to take vengeance of this sin,[3] and I wish to point out that if the artist is to make a reality which expresses an idea, he, too, is but a mechanical device for reproducing a model, namely, the idea, which is already set for him. This scarcely seems to do justice to the creative element in art. Nor should I agree that the artist always seeks to please, while the metaphysician aims to tell the truth, whether pleasant or not. The artist rather seeks to interest, to impress and to stimulate, and that, too, whether we like it or not. Does Tolstoi or does Hardy ever hesitate to let us have an unpleasant truth if he thinks we ought to get it?

2. Dr. Ewer does not find that my analysis of categories into motor attitudes, and hence emotions, is supported by his introspection, and he could not, therefore, of course, agree with conclusions based upon it. He finds that 'speculation, upon the nature of time or space for instance, may proceed without other emotional consciousness than satisfaction in the search for truth.'[4] All I can say is that when I make the attempt myself to appreciate or at all realize the meaning of space and time or any abstract category, and when I witness the contortions of others who are trying to be intelligible upon these subjects, I can not but envy the Brahmic calm of one who feels only the 'satisfaction in the search for truth.'

3. One of Dr. Ewer's citations from my article seems to me somewhat indiscriminately severed from its context. He says: "And finally, the charge that Augustine's solution of skepticism and Kant's ethical prescription have no result upon overt action seems to me in the plainest contradiction to facts."[5] Whereas my text reads:[6] ". . . Or take Kant's prescription of 'simple conformity to law in general.' What result would that have upon overt action? Some result at some time, of course, but nothing that we can immediately indicate." The criterion in this passage, as in the discussion which precedes it, is immediacy and not overtness, as Dr. Ewer has assumed it to be.

4. Finally, it would have been more satisfactory if Dr. Ewer had stated somewhat explicitly what the resemblance is between metaphysics and science. He admits and emphasizes the art-qualities in metaphysics, and he says that metaphysics is not science in the ordi-

[3] Especially in Moore's monograph, 'The Functional *vs.* the Representational Theories of Knowledge in Locke's Essay,' this point of view seems to be adequately met, not to say swallowed.

[4] P. 547.

[5] P. 548.

[6] This JOURNAL, Vol. III., No. 14, p. 370.

nary usage of the term. But in what usage of the term it is science he does not reveal.

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REVIEWS AND ABSTRACTS OF LITERATURE

La théorie physique; son objet et sa structure. P. DUHEM. Paris: Chevalier & Rivière. 1906. Pp. 450.

This volume is the book-form of the series of articles which first appeared in the *Revue de philosophie* for 1905.

The author is recognized as one of the foremost authorities and scholars in his line; from him there have come a number of highly valued and exhaustive treatises on chemical mechanics, on hydrodynamics and on electricity and magnetism, as well as other and more simple works written with a distinctly didactic purpose. One of the most important characteristics of all of this systematic work in these diverse fields is the acceptance and use, in each of them, of certain fundamental principles by which a unification or 'natural classification' is brought into the treatment of the various classes of physical phenomena. That principle which in particular enables him to do this is the generalized 'second law,' which was developed first in thermodynamics, and according to which, in its extended form, every energy-transfer 'goes out' from the higher potential to the lower, provided such a potential difference is uncompensated, etc. The author thus allies himself closely with Nernst, Gibbs, Mach and a number of other leading physicists. From time to time he has appeared as an opponent of Poincaré concerning various questions.

This present work of his, together with some other contributions, places him in that rapidly growing group of scientists who look at their science retrospectively, analytically, broadly, or, as one might say, philosophically. In reading it one feels that he has before him the exposition of a master, of one who not only knows and uses the technique, but who also sees the logically and historically significant thing, and who speaks, therefore, with well-justified confidence. However, in this review it is possible only to indicate a few important main points out of much that is of great value in the matter presented.

The volume consists of two parts, the first dealing with 'the object of physical theory,' the second with its 'structure.' The first part is divided into four chapters, and each of these into a number of sections.

In Chapter I., in which there is discussed the relation between 'physical theory and metaphysical explanation,' M. Duhem finds that neither historically nor logically is the former subordinate to the latter, but that it is autonomous. To state simply just what the author means by 'physical theory' is at this point impossible, since, indeed, the elucidation of this is the purpose, in great part, of his subsequent discussions. By 'metaphysical explanation' there are referred to, as it becomes clear later, views as to the ultimate nature of physical phenomena, assumptions

as to something behind sense-given data and hidden from immediate perception. Metaphysics, he finds, has been sterile as a source from which to draw principles for physical theory; but he does not refer here to such *a priori* and constitutive principles as those of Kant's critique.

Chapter II. The purpose of physical theory is, indeed, not explanation; rather, physical theory is a system of mathematical propositions deduced from a small number of hypotheses, and its purpose is to represent 'as simply, completely and exactly as possible an ensemble of experimental laws.' Between theory and experimental laws a fairly exact distinction is made, here and subsequently. Four 'operations' are necessary to theory: first, the choosing of simple properties and the establishing, by measurement, of a correspondence between these and mathematical symbols; measurement gives for each physical property a numerical value of its sign. Secondly, hypotheses must be chosen as principles of deduction, by which the various kinds of quantities are brought into relation. Thirdly, there is the mathematical development, in which the various hypotheses of a theory are combined according to the rules of mathematical analysis. Fourthly, the consequences thus drawn can be translated into judgments concerning physical properties; if it be found that these judgments, when compared with experimental laws, agree approximately, then has theory fulfilled its purpose.

Chapter III. Such a theory—and here is an important point methodologically—constitutes a *natural classification* of experimental laws; thereby do their real affinities, their ontological relations, become known, not, however, in a manner which consists in or is satisfied by the formation of images and the construction of models. The purpose of theory is, then, to condense, to classify, to predict. But do not these constitute explanation? No! 'Something behind the senses' is not thereby gotten at, but rather, by an analysis and comparison made by mathematical means, there are discovered common properties which can be treated and known only by symbolic methods. This is called by our author representation or description, and constitutes the autonomy of physical science.

Chapter IV. Not all men, however, can 'comprehend' such an abstract theory; some must present things as seen or touched, and, therefore, they construct models for the details of theory. This characterizes the English physicist in particular, with his predilection for mechanics and explanation. On the other hand, for the French and Germans a physical theory is a logical system rigorously deduced and satisfying reason rather than imagination; if algebra is used, it can be replaced by logic. Starting with, for example, two categories of distinct phenomena, within the realm of theory it may be found that the fundamental algebraical equation of one is identical with that of the other; each, therefore, helps to 'clear up' the other.

The second part consists of seven chapters.

Chapter I. It may be difficult to get such a mathematical physics, logically rigorous, etc., but it can be accomplished by the use of symbolic methods. Each idea can be represented by a sign, and so defined unam-

biguously; each phase of reasoning can be replaced by an operation which combines signs according to fixed rules. For this it is necessary that each notion should have a numerical value, each physical attribute be signified by a numerical symbol. Here the well-known distinction is made, that physical phenomena are both extensities and intensities. To the former the associative and commutative laws are applicable; the symbolic addition $A + B + C + \cdots$ can be replaced, through the medium of measurement of length, surface, volume, etc., by real arithmetical addition. On the other hand, intensities can not be 'summed' or analyzed in this way. 'Each intensity of a quality has its own individual character'; it does not contain as an integral part the lesser intensity. However, contrary to the view of some physicists that their science deals only with extensities and that these are the realities behind the qualities as appearances, this does not make it impossible to express the various intensities of a quality by numbers. For physical theory represents sense qualities by signs or symbols; these are algebraical; they are made numerical by measurement. The means for this is a *scale,* which is the quantitative effect of a qualitative cause. Thus the intensity of a quality can be represented adequately by a numerical symbol. Then an algebraical treatment is possible; the scale mediates the substitution of numbers, which can be added, although they refer to intensities which can not be. In this way physical science can be built up without any dependence on hypotheses 'as to the nature' of phenomena; such a physics is descriptive, 'representative,' autonomous.

Chapter II. But, proceeding in this manner, a minimum number of simple irreducible qualities should be made use of. What is the criterion for these? Duhem's answer to this is important philosophically. Instead of drawing the criterion from philosophy, as does explicative physics, one should let this result from autonomous procedure. It is not known beforehand what qualities are primary; this is a relative term, meaning 'not yet reduced.' In illustration there is cited the reduction of light to an electromagnetic phenomenon. The geometrical symbol for light is a curved line; treating this mathematically, its components, etc., make it possible to write certain equations to partial derivatives so that the empirical laws of propagation, reflection, refraction and diffraction are 'classified' with an admirable brevity and order. Proceeding in an analogous way for dielectrical polarization, it is finally found that the equations for this have the same form, the coefficients the same numerical value, as do those for 'luminous vibrations.' The conclusion is that 'light is not a primary quality,' that 'light vibration' is nothing else than a dielectric polarization periodically variable.

Chapter III. treats of 'mathematical deduction'; the rôle of this is the development of that 'edifice' whose foundation is the measurement of qualities and the choice of hypotheses. It forms an intermediate operation with the concrete at either end, and proves useful or not, according as the conditions started with enable prevision.

Chapter IV. presents a standpoint which would be of great value to

those extreme empiricists who would have all physical science consist only in 'getting at the facts experimentally' and would exclude all theory. Our author shows that the 'experience' of the physicist is not simply observation, but is also its theoretical interpretation. Instruments must be used, and these can be constructed and the results which they give can have a meaning only in the light of theory. Words like volts, electromagnetic force, etc., do not express directly an object visible and tangible; the scientist's language presupposes theory. Instruments can be used only if it is possible to substitute for concrete objects a representation, abstract, symbolic, schematic, and to submit this combination of 'abstract' representations to a deduction and calculation which imply adhesion to theories. Only in this way does the interpretation, *i. e.*, the meaning, of an experiment become possible. By the use of the concrete instrument before him the physicist gets definite numerical values for certain symbols created by theories; but over against this there is 'in his mind' the 'ideal' instrument, and it is upon this that he reasons.

Chapter V. deals with the character of a physical law. "Laws are symbolic relations." They transcend themselves, for between symbol and thing a correspondence is established by means of instruments, thus implying theory. "Strictly speaking, a law is neither true nor false, but approximate." For each series of facts there may be an infinity of laws, and conversely. Because it is both approximate and symbolic, every physical law is provisory and relative; by progress it gains in precision, and since the symbols may prove too simple to represent reality completely and adequately, it demands continual retouching.

Chapter VI. Under what circumstances is physical theory confirmed? For this confirmation a twofold apparatus, concrete and ideal (schematic), is necessary. But, since both the concrete instrument and the interpretation of the results gained by it, etc., imply adhesion to an 'ensemble' of laws, in the event of failure to confirm, not one law but the ensemble is shown to be at fault or to require modification and retouching. For this reason the 'crucial experiment,' which would proceed by eliminating all hypotheses but one and testing this one, is impossible; this elimination can not be practised. The only experimental control which is not illogical consists in comparing the entire system of physical theory with the ensemble of experimental laws and *appraising* if the former represents the latter in a satisfactory manner.

In the development of physical theory, that which the author has called the third step, use must be made not only of symbols and of logical laws and algebraic rules, but also of postulates. The selection of these is, to a certain extent, arbitrary; there must be no contradiction among them; but neither they nor the intermediate steps of the development which is made by their use need seek the direct control of sense experience. The 'operations' of the development have no 'physical sense.'

Chapter VII. What, then, determines the choice of hypotheses? The condition is not that they should have a 'physical sense,' nor that they should give the 'nature of things.' And they are not purely inductive

laws, for pure induction is impossible. Rather, hypotheses should be so chosen that by their use in their ensemble mathematical deduction can draw consequences which represent with sufficient approximation the ensemble of experimental laws. The schematic representation, by mathematical symbols, of experimental laws is the purpose of physical theory. The hypotheses chosen and used are accordingly the result of a progressive evolution, and a repeated retouching is necessary. It may even be said that they are not chosen, but that they 'germinate' in the physicist because of his habits of thought in the traditions of the science.

The author closes the volume with a discussion as to the manner in which physics should be taught; he finds that in every exposition a compromise must be made between the exigencies of logic and the intellectual needs of the student.

In this review it has been impossible, because of the full and thoroughgoing presentation which the author makes, to do more than give an outline of his position with reference to the many phases of physical science. However, the volume contains a great deal which is both stimulating to reflection and demanding of discussion. Evidence of this is to be found, indeed, in the very lively discussions and appreciative reviews which it has excited in the French periodicals. The general position which M. Duhem takes seems to me to be of especial opportuneness and interest in connection with current agitation as to radical empiricism and pragmatism. To his view as to hypotheses, the 'standing' of qualities, the purpose of theory, and the means to attain this, the pragmatist might, perhaps, point with satisfaction at finding a position, sympathetic to his own, yet taken by an active physicist. But for M. Duhem this is methodological pragmatism. With the position which goes farther than this and finds in this pragmatism the implications of an ontological doctrine, one with whose outlines we have all been made familiar recently, doubtless much to their disappointment some of our pragmatists would not find him to be in agreement. Capable, indeed, of reasoning rigorously in the field of mathematical physics, he fails to disclose the discovery of any such implications. Is this omission, or does rigorous thinking desert him here?

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The Psychology of the Simple Arithmetical Processes: A Study of Certain Habits of Attention and Association. CHARLES E. BROWNE. *The American Journal of Psychology,* January, 1906. Pp. 1–37.

The study is provided with a full table of contents. The writer's careful summaries will be of use to readers, who will find the article worth their attention. Nine subjects served in the experiments, which were concerned with two types of procedure in arithmetical process: (1) purely mental from visual cues, (2) written and more complex.

It is found that a specific mental attitude corresponds to each of the four main processes, and this is further differentiated as multipliers or

divisors vary in size. This attitude is strengthened by the early steps of the problem.

A few of the results of the adding experiments may be mentioned. The tendency to motor expression is a prominent feature of this as of all the arithmetical processes, and increases with the difficulties met. Each step of the adding psychosis contains three phases: recognition of the result thus far, which becomes motorized; recognition of the digit to be added, visual; and a subconscious associative process. The tendencies to error include mental distraction, fatigue and mental vacuity, and false associations often due to the force of similarity, false substitutions either of method or of result. Another kind of error is the skipping or confusing of tens, as when one forgets whether the sum thus far is, say, 66 or 76, due to the lack of emphasis that the tens receive in motorization. Too fast or too slow a tempo decreases accuracy, the latter because it gives more chance for mind-wandering and strengthening of irrelevant associations. The feeling of accuracy is distinguished from the knowledge that one is right; the former is normally subconscious and seems to consist in the absence of the feeling of error. The adding of even numbers or any factorable series is relatively easy since the associative bond is strong in proportion as it involves primitive links like those of counting. Correlation with Ebbinghaus's memory tests is shown in the law that ease of combining is directly proportional to the difference between the two digits, or inversely to the size of the smaller. 'Counting is purely a verbal formula,' quite as arbitrary as a series of nonsense syllables.

Incipient motorization of results is a relic of one's early practise of counting and of addition tables, and is the root of the feeling of assurance. A similar fact holds of the other arithmetical processes. In many subjects a tendency was discovered for other aspects of the psychical process to run ahead of this motor fixation of the results, bringing danger of confusion or error. This indicates essential limits to the variation of different subjects in their mode of motorizing: in adding, lingual motorization is either gradual and prolonged or inhibited and sudden, the latter involving excess of strain alternating with recovery; in multiplying, if the problem is difficult, manual motorization is gradual, otherwise it follows as a 'detached and automatic part of the process.'

In multiplication, two types of difficulty are discovered: that of carrying and that of adding. According to the author, one cause of the former is as follows: In multiplication, visual are of little importance as compared with motor images. "Here there seems to be a clash of motor images. The motor ten of the foregoing product is to be added to the following motor product." But while in ordinary addition a motor and a visual image may coexist and be readily combined, two simultaneous motor images can not share the attention. This view has some plausibility, but it is possible that the author fails here to distinguish between images and sensations. If two visual or two auditory images can be noted together, there is nothing improbable in a similar coexist-

ence of two motor images. At this point the study also neglects the influence of practise in effecting difficult combinations. Therefore one may hesitate to accept the writer's first pedagogical corollary, *viz.*, to adopt 'the method of writing the entire products at each step' and concluding the process with addition, as a remedy for the above. His other corollaries seem well founded: the need of thorough mastery of the multiplication tables as an instrument and a standard, of simplifying the verbal formula employed therein to guard against fatigue through motorization, and of diminishing the size of the tables *en masse* by one half, because three 9's equal nine 3's.

Subtraction and division are found to be harder than addition and multiplication because of the reverse order of the associative bonds involved; the former are said to be 'far more immediate' than the latter, though 'far *less* practised,'[1] and to be marked by less confidence and by 'proving.' These relations account for the method of 'subtracting by adding,' which in practise, however, gives way to 'immediate association.'[2] The resulting digit is written automatically, perhaps from an unnoticed visual cue, and the act may be either explosive or gradual. Borrowing is attended with difficulties, such as the 'possibility of having to visualize a 4, say, with a perceived 5 directly in the field of vision.' The author gives a detailed analysis of the process, attended with diagrams showing the order of the attentive movement in different methods of subtracting. From this it is concluded that the method of increasing the subtrahend is superior to that of decreasing the minuend, because in the former there intervenes in the mental process, between the borrowing and the returning, a less number of focal points to be disturbed or, conversely, to disturb the memory of borrowing. Details can not be given further here, but the demonstration is excellent.

Purely mental division seems attended by more assurance than subtraction, so that 'verification tends to fall away.' The quotient is often reached by a process of multiplication. Errors commonly consist in substituting a wrong factoral divisor or in the functioning of a mechanical run-on association leading to counting or repeating a digit instead of dividing. Difficulty in dividing varies with the ratio in size between the divisor and partial dividend. The writing of the result tends to become an automatic process running parallel to the mental process. This automatic movement is more efficient when evenly sustained than when consisting in the sudden writing of a digit after the mental result is assured, for the latter makes a break in the mental process, and is more fatiguing.

The author organizes his facts well from the point of view of the topics indicated in the title of the article. He dwells on the interrelation of the four processes, and studies fully the usual types of error. With the prominence of the distinction between true and false, between valid

[1] P. 23. Italics mine.

[2] P. 30. The immediate is then decidedly the result of mediation and practise.

and invalid processes, his point of view is in part that of functional psychology. The idea of control under the dominance of mathematical purpose is plainly implied, but the study of purpose itself and of the logical significance of these processes as a whole or in their elements was beyond the scope of the article. It is not a far step, however, to the recognition of the conceptual value of the number images, whether motor, auditory or visual, and of the instrumental value, subsidiary to arithmetical thinking, of the more automatic processes. Even these simple arithmetical processes involve concepts and judgments, they are not mere mechanical associations. Every exercise in the experiments described was an attempt by the subject to solve a problem within this thought field. While the names of numbers may be arbitrary, even counting, when it is real counting and aroused by a genuine stimulus, is organic rather than mechanical. Its mechanization is only explained by the need of such a solid basis for the solution of more elaborate problems such as those of simple addition. Addition differs from counting in being a more highly organized activity having a selective control of habitual associative processes identical with or based upon those of counting. Thus such a psychological study as that reviewed is not far from a logical study whose aim is to point out the nature of erroneous processes, their conditions, and how to avoid them. The article expresses its affiliation with pedagogy, and this also shows the natural interlacing of the normative and the descriptive points of view.

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UNIVERSITY OF ILLINOIS.

JOURNALS AND NEW BOOKS

ZEITSCHRIFT FÜR PSYCHOLOGIE UND PHYSIOLOGIE DER SINNESORGANE. March, 1906, Band 41, Heft 2 u. 3. Abteilung für Psychologie. *Untersuchungen über psychische Hemmung* (Schluss): G. HEYMANS. – In visual contrast with a constant relation between background and field the latter was reduced in brightness, which reduction was independent of the absolute light intensity; or, in the language of the inhibition theory, for intensive contrast as well as for suppression previously established, the coefficient of inhibition is constant. The results when the relation was varied to the point of suppression lead to the view that positive contrast, negative contrast and suppression are not different facts but merely exemplifications of varying degrees of inhibition. Theoretical observations on the distribution of mental energy follow. *Merkfähigkeit, Gedächtnis und Association* (Schluss): KURT GOLDSTEIN. – Experiments on memory in the feeble-minded. Results show that it is necessary to distinguish memory proper and capacity of observation. Impression (*Einprägung*) and capacity of associative observation common to both; memory proper depends more on the latter. Imbecility is characterized by lack of associative observation; acquired feeble-mindedness by lack of capacity for impression. In acquired feeble-

mindedness retention may be relatively unimpaired, but the power of observation disturbed; in congenital feeble-mindedness the reverse. A third necessary condition to acquisition is apperceptive *Anlage,* the lack of which is the chief defect in congenital feeble-mindedness. *Wie rahmen wir unsere Bilder ein?:* MAX FOTH. – The nature of the frame of a picture is determined not so much by direct factors, such as dominant color-tones, complementary colors, etc., but rather by associative factors, such as come from indirect vision, actual environment of scene, etc. The color-tone as well as the degree of brightness of the frame should suggest the natural surroundings of the object depicted. Same principle holds for form and material. *Die Quarte als Zusammenklang:* RICHARD HOHENEMSER. – Analysis of the reasons for regarding the fourth as a consonant interval. *Literaturbericht.*

Abbot, Francis Ellingwood. *The Syllogistic Philosophy or Prolegomena to Science.* In two volumes. Boston: Little, Brown & Co. 1906. Pp. xii + 317; vi + 376. $5 *net.*

Arnold, G. F. *Psychology Applied to Legal Evidence.* Calcutta: Thacker, Spink & Co.; London: W. Thacker & Co. 1906. Pp. ix + 470. 12s. *net.*

Deussen, Paul. *Outline of the Vedanta.* Outline of the Vedanta system of philosophy according to Shankara. Translated by J. H. Woods and C. B. Runkle. New York: The Grafton Press. 1906. Pp. vi + 45. $1.50 *net.*

Ormond, Alexander Thomas. *Concepts of Philosophy.* New York and London: The Macmillan Co. 1906. Pp. xxxi + 722.

Williams, Henry Smith, assisted by Edward H. Williams. *A History of Science.* In five volumes. Vol. I.: The Beginnings of Science; Vol. II.: The Beginnings of Modern Science; Vol. III.: Modern Development of the Physical Sciences; Vol. IV.: Modern Development of the Chemical and Biological Sciences; Vol. V.: Aspects of Recent Science. New York and London: Harper & Bros. 1906. Pp. vii + 309; ix + 308; ix + 308; ix + 306; ix + 300.

NOTES AND NEWS

THE *Minnesota Alumni Weekly* of October 8 makes the following announcement: "Increased interest and membership in the department of philosophy and psychology have resulted in the organization of the Philosophical Club, the purpose of which is to promote the discussion of broader aspects of science and life. Membership is open to all faculty members interested in philosophy and to all past or present students of the department, the only formality being acceptance by the executive committee of the club. During the year the club will present a series of public lectures in which representatives of various sciences will discuss

some of the first principles or final conclusions of their work as data for philosophic study, the aim being in this way to obtain insight into unity and organization of knowledge. During the first semester the lectures will be ethical in character under the general heading of Science and Life. The program so far as arranged is as follows: 'The Ethical Basis of Law,' Dean Pattee, October 19; 'Literature and Life,' Dr. Burton, November 2; 'Biology and Life,' Dr. Sigerfoos, November 9; 'Economics and Life,' Dr. McVey, November 16; 'Religion and Life,' ————, November 23; 'Philosophy and Life,' Mr. Swenson, December 7. The lectures will be open to all interested and will be given in the Library, room 18, at four o'clock. Besides these public lectures the club will have a smaller reading circle composed of selected students and devoted to the discussion of current philosophy."

THE discussion in England of classical education brings out occasionally observations worth repeating. The following is from *Nature* for September 20: "Speaking at Hawarden on Monday on the objects and advantages of education, Mr. Wyndham remarked that 'it was right to include science in the curriculum because we are now living in an age of science. In the sixteenth century people lived in an age of literature, and the minds of men were attracted toward the old books written in Greek and Latin.' This difference between the needs of the two ages was pointed out by Sir Norman Lockyer in an address at the Borough Polytechnic Institute last December, printed in *Nature* of March 29, as the following extract from the address clearly shows: 'We must arrange our education in some way in relation to the crying needs of the time. The least little dip into the history of the old universities will prick the bubble of classical education as it is presented to us to-day. Latin was not learned because it had the most magnificent grammar of known languages. Greek was not learned in consequence of the transcendental sublimity of ancient Greek civilization. Both these things were learned because people had to learn them to get their daily bread, either as theologians or doctors or lawyers, and while they learned them the "nature of things" was not forgotten. Now what is the problem of to-day? We are in a world which has been entirely changed by the advent of modern science, modern nations and modern industries, and it is therefore perfectly obvious that if we wish to do the best for our education it must be in some relation to those three great changes which have come on the world since the old days.'"

THE *Century* for September contains an article by Dr. R. B. Bean entitled 'The Negro Brain.' Dr. Bean does not believe that the negro and the white man are brothers. He sums up as follows: "The white and the black races are antipodal in cardinal points. The one has a large frontal region of the brain, the other a larger region behind; the one is a great reasoner, the other preeminently emotional; the one domineering, but having great self-control, the other meek and submissive, but violent and lacking self-control when the passions are aroused; the one a very advanced race, the other a very backward one. The Caucasian and the negro are fundamentally opposite extremes in evolution."

THE following is taken from a communication to *Science* for October 5: "Dr. S. Auerbach has published an interesting contribution to the cerebral localization of the musical talent in a description of the surface morphology of the brain of Professor Naret Koning, late director of the opera in Frankfurt a. M. The report includes a comparative study of the brain of the celebrated composer Hans v. Bülow, for some time in the possession of Professor Edinger, and of brains of other eminent men, of known musical talent, previously described. The author finds in the considerable breadth and configuration of the (supra) marginal gyre, as well as the adjacent portion of the supertemporal gyre, an expression of the greater aptitude for the multitudinous associations in the auditory sphere which distinguished these persons from others less musical. The author goes on to show that the corresponding portions of the skull usually indicate this redundancy."

THE Open Court Publishing Company has just issued, as one of its series of *Philosophical Classics*, Fichte's 'Vocation of Man,' in William Smith's translation, edited with introduction by Dr. E. Ritchie. Two other books of the same series are reissued with additions. To the edition of Locke's 'Essay' (Books II. and IV. with omissions) is prefixed a reprint of the rare English translation of Leclerc's 'Eloge'—the inimitable little memoir on which most of the later biographies are based. The edition of Hume's 'Enquiry concerning Human Understanding' is supplemented by selected chapters of the 'Treatise' setting forth Hume's doctrine of substance, barely touched on in the 'Enquiry,' and amplifying the teaching of the 'Enquiry' about causality.

CHAS. HUGHES JOHNSTON, Ph.D. (Harvard), last year professor of psychology at East Stroudsburg State Normal School, is now instructor in philosophy and psychology at Dartmouth College. Some psychological apparatus is being secured for the college, which, it is hoped, may form the nucleus for a psychological laboratory in the near future.

THE guests of the University of Aberdeen at its recently celebrated four hundredth anniversary included Professors H. Höffding, Hugo Münsterberg, Lombroso and W. Ostwald.

THE publishing house of Fischer Unwin announces a volume entitled 'Thomas Davidson, the Wandering Scholar,' by Professor William Knight. Numerous friends and pupils contribute their estimates and impressions.

DUTTON AND COMPANY have the sole publishing rights in this country of Guenther's 'Darwinism and the Problems of Life.' The book is published in London by A. Owen and Company.

The Journal of Philosophy Psychology and Scientific Methods

There is no similar journal in the field of scientific philosophy. It is issued fortnightly and permits the quick publication of short contributions, prompt reviews and timely discussions. The contents of the last five issues are as follows.

Volume III. No. 17. August 16, 1906.

Reality as Possible Experience. M. PHILLIPS MASON.
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The Relation of Feeling and Interest. LUCINDA PEARL BOGGS.
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Volume III. No. 18. August 30, 1906.

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Reviews and Abstracts of Literature. Journals and New Books. Notes and News.

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Self as a Developed Feeling Complex. E. A. NORRIS.
Discussion: The Function of Thought. A. W. MOORE.
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Volume III. No. 20. September 27, 1906.

Space and Reality. I. Ideal or Serial Space. JOHN E. BOODIN.
A New Logical Diagram. WM. J. NEWLIN.
Discussion: Metaphysics, Science or Art. BERNARD C. EWER.
Reviews and Abstracts of Literature. Journals and New Books. Notes and News.

Volume III. No. 21. October 11, 1906.

Psychological Opportunity in Psychiatry. SHEPHERD IVORY FRANZ.
The Given Situation in Attention. FELIX ARNOLD.
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